

NATURAL HISTORY MISCELLANEA

Published by

The Chicago Academy of Sciences

Lincoln Park-2001 N. Clark St. Chicago, Illinois 60614 U.S.A.

No. 213

June 15, 1981

**Distribution and Systematics of the
Masked Shrew (*Sorex cinereus*) in Illinois**

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INTRODUCTION

In North America, the masked shrew, *Sorex cinereus*, occurs throughout most of Alaska, Canada, and the northern third of the United States with finger-like extensions projecting southward along the Rocky and Appalachian mountains. In Illinois, this species was known only from the northern third of the state until 1979 when G. R. Squire collected a specimen near the Wabash River in southeastern Illinois and 1980 when Woodrow W. Goodpaster collected two specimens near the southern tip of the state close to the junction of the Mississippi and Ohio rivers. The northern and southern populations in Illinois may be disjunct morphologically, if not geographically, and this brings into question the systematic status of each group. Therefore, an investigation into the phenetic variation of this species in this region was undertaken.

METHODS AND ACKNOWLEDGMENTS

All available specimens of *S. cinereus* from Illinois were examined. Since the type locality of *S. cinereus lesueurii* is in adjacent Indiana, representative specimens were examined from there. Twenty-one of the 24 cranial and dental measurements used by Diersing (1980) were taken from each skull. Braincase breadth, condylobasilar length, and length of the secondary cusp of the first upper incisor were not recorded. In addition, toothrow length was taken according to Diersing and Hoffmeister (1977). U refers to unicuspid, each of which is designated by a superior number. Two external measurements (total and tail lengths) were taken from each skin tag when available. Head and body length was calculated. Canonical variate and discriminant function analyses were done on the University of Illinois CYBER 175 Computer. In all analyses, all ages and both sexes were combined.

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For the analysis of geographic variation by canonical variate analysis, all individuals were grouped into one of six samples (see Figure 4). The six samples are: (1) northern Illinois (Carroll, Cook, Du Page, Kankakee, Kendall, Stephensen, Whiteside, and Winnebago counties, $n = 16$); (2) central Illinois (Fulton and Mc Lean counties, $n = 21$); (3) northern Indiana (Jasper, Marshall, Pulaski, Wabash, and White counties, $n = 12$); (4) west-central Indiana (Knox and Vigo counties, $n = 7$); (5) southwestern Indiana (Posey County, $n = 12$); and (6) southern Illinois (Alexander and Edwards counties, $n = 2$).

Acknowledgment is made to the Illinois Department of Conservation and its director, David Kenney, for financial assistance with the project entitled "Mammals of Illinois". Our appreciation is also extended to A. Prickett for preparation of the illustrations. We thank those people at the following institutions who allowed us to examine specimens in their collections. These people and their respective institutions (institutional acronyms follow the name and location of the institution) are: L. de la Torre, then at the Field Museum of Natural History, Chicago (FMNH); L. Page, Illinois Natural History Survey, Urbana, (INHS); D. E. Birkenholz, Illinois State University, Normal (ILLSU); J. E. Warnock, Western Illinois University, Macomb (WIU); W. D. Klimstra, Southern Illinois University, Cooperative Wildlife Research Laboratory, Carbondale (CWRL); J. O. Whitaker, Jr., Indiana State University, Terre Haute (ISU); D. E. Wilson, National Fish and Wildlife Laboratory, National Museum of Natural History, Washington, D.C. (USNM).

RESULTS

Using 22 cranial characters, a canonical variate analysis of the six samples (Figure 1) illustrates that shrews from northern and central Illinois and northern and west-central Indiana (samples 1-4) are graphically interconnected in the character space to form one phenetically coherent group. Shrews from southern Illinois and southwestern Indiana form a second coherent group (samples 5 and 6). The separation of these two groups is largely on the first canonical vector, which accounts for 59.15% of the total observed phenetic variation. The characters contributing the most to the separation of these two groups on the first vector are: breadth U^1-U^1 , 18.8%; molariform toothrow length, 11.7%; breadth $U4-U4$, 11.5%; and maxillary breadth, 8.7%. The second canonical variate accounts for an additional 15.51% of the total variation, partially separating shrews from central Illinois (sample 2) from those in northern Illinois and northern and west-central Indiana (samples 1, 3, 4).

As indicated in the canonical variate analysis (Figure 1), shrews of sample 4 from west-central Indiana cluster more closely with shrews from northern Illinois and Indiana (samples 1-3). However, on a geographical basis, shrews from west-central Indiana would

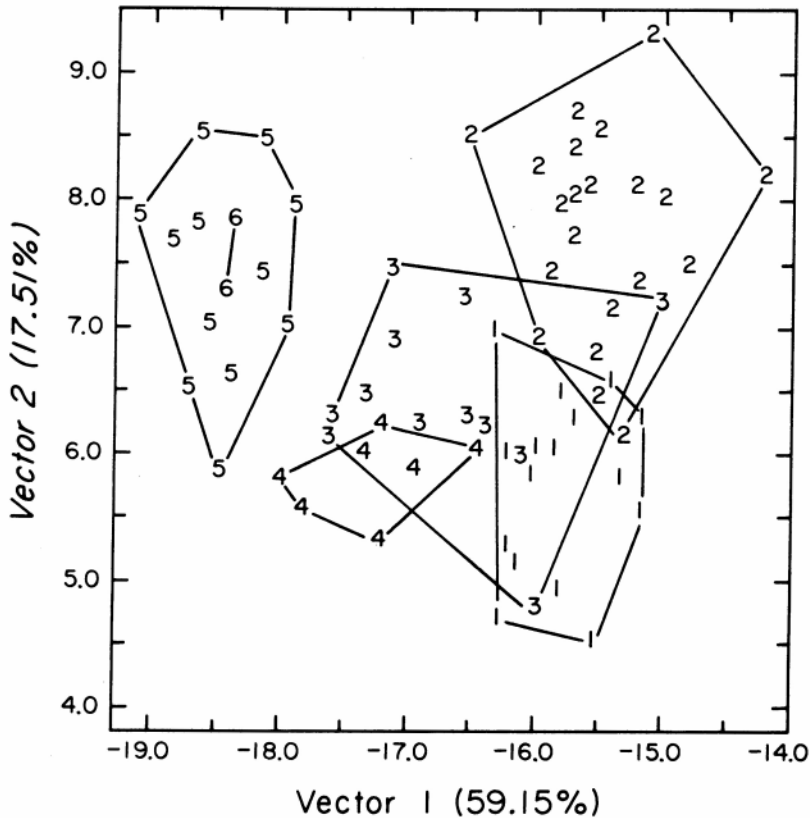


Figure 1. A canonical analysis illustrating the phenetic relationships of the six samples (Figure 4) of *Sorex cinereus* from Illinois and Indiana. Each number represents one individual of a designated sample. Each set of connecting lines group all individuals of a sample.

seem to be morphologically nearest to specimens from southern Illinois and southwestern Indiana (samples 5 and 6). Therefore, a discriminant function analysis was used (Figure 2) to establish better phenetic affinities of shrews from Vigo and Knox counties in west-central Indiana (sample 4). Two reference groups were created for the analysis. Northern shrews comprised one group (samples 1-3, $n = 49$) and southern shrews comprised the other group (samples 5 and 6, $n = 14$). The thirteen cranial characters and their discriminate multipliers used in the analysis are given in Table 1. The two reference groups are completely separated by a

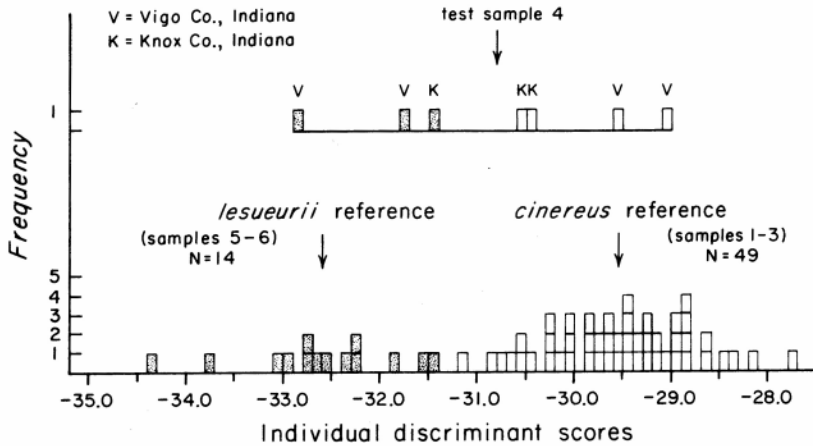


Figure 2. Histogram of a discriminant function analysis showing intergradation between *Sorex cinereus cinereus* and *S. c. lesueurii*. The samples referred to are shown in Figure 4. The test sample contains individuals of the geographically intermediate sample 4. Arrows designate group means. The 13 cranial characters used for the analysis and their discriminant multipliers are given in Table 1.

Table 1. The 13 cranial characters and their discriminant multipliers used in a discriminant function analysis (Fig. 2) testing for intergradation between *S. c. cinereus* and *S. c. lesueurii* in Illinois and Indiana.

Character	Discriminant multiplier
Breadth $U^1 - U^1$	18.33
Breadth $U^2 - U^2$	- 2.61
Breadth $U^3 - U^3$	1.81
Breadth $U^4 - U^4$	- 8.86
Breadth $U^5 - U^5$	1.12
Breadth $PM^4 - PM^4$	4.91
Breadth $M^2 - M^2$	-10.73
Breadth $M^3 - M^3$	4.64
Tooththrow length	- 6.16
Unicuspid tooththrow length	7.58
Molariform tooththrow length	- 2.43
Maxillary breadth	- 0.91
Lateral breadth U^1	- 4.75

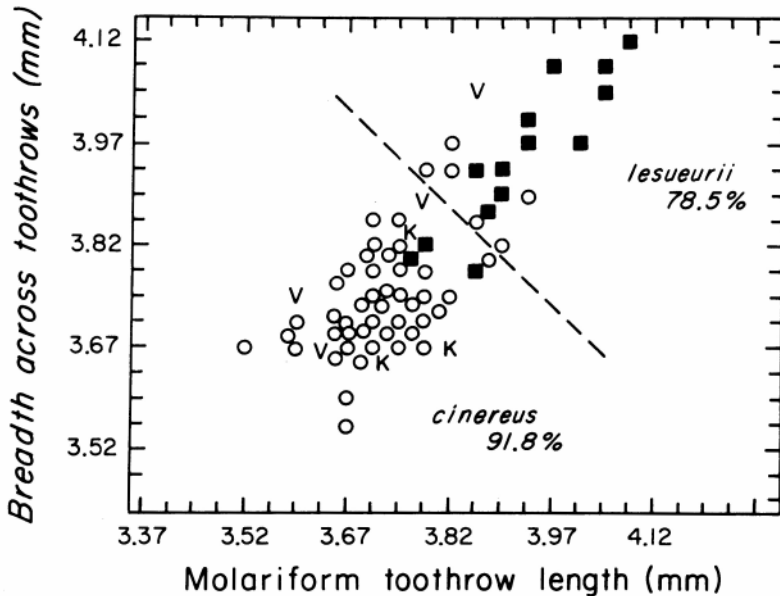


Figure 3. A scattergram comparison of *S. c. cinereus* (open circles, V's, and K's) and *S. c. lesueurii* (closed squares). Approximately 79% of the individuals of *S. c. lesueurii* occur above the line and 91.8% of the *S. c. cinereus* are below the line. "V" and "K" represent individuals from Vigo and Knox counties, Indiana (sample 4).

discriminant distance of 0.30. Characters that differed the most between the two reference groups, as determined by F-values, are: molariform toothrow length, breadth M^2-M^2 , and breadth $M3-M3$.

Individuals of the test sample (sample 4) overlap both reference groups. Of the four specimens from Vigo County (V), two overlap the southern reference group (scores of 31.7 and 32.8) and two overlap the northern reference group (29.0 and 29.5). Of the three individuals from Knox County (K), two overlap the northern reference group (30.4 and 30.5) and one barely overlaps the southern reference group (31.4). The average score of the seven specimens from Vigo and Knox counties is 30.80, which is nearly intermediate between the two reference groups but slightly closer to the northern reference group.

In a scattergram analysis (Figure 3) molariform toothrow length was plotted against breadth M^2-M^2 . Approximately 79% of the southern specimens (samples 5 and 6) occur above the dashed line and 91.8% of the northern individuals (samples 1-3) are smaller in these two measurements and occur below the line. Six of the seven specimens from Vigo and Knox counties, Indiana (sample 4), cluster with the northern group.

DISCUSSION

Sorex cinereus in Illinois and western Indiana can be grouped into two morphological units: a northern form characterized by generally overall small cranial size with long unicuspid tooththrows and a southern form characterized by generally overall large cranial size with relatively short unicuspid tooththrows. The northern form occupies the northern third of Illinois and the northern half of Indiana (samples 1-3) and is referable to the subspecies *S. c. cinereus*. The southern form occurs from the southern tip of Illinois northeast to the southwestern tip of Indiana (samples 5 and 6) and is referable to the subspecies *S. c. lesueurii*. Intergradation between these two subspecies is evident from individuals that occur in a narrow zone of west-central Indiana from Vigo County south through Knox County (sample 4 of Figure 4). The phenotype of this intergrading sample averages closer to the morphology of the northern shrews. Therefore, shrews from west-central Indiana are tentatively referred to *S. c. cinereus*.

TAXONOMY

Sorex cinereus lesueurii (Duvernoy)

1842. *Amphisorex lesueurii* Duvernoy, Mag. Zool. d' Anat. Comp. et Paleont., 1842, livr. 25, p. 33, pl. 50.

1942. *Sorex cinereus lesueurii*, Bole and Moulthrop, Sci. Publs., Cleveland Mus. Nat. Hist., 5:95.

Type.—Fixed at New Harmony, Posey County, Indiana. See *Remarks* for a discussion of selecting New Harmony as the type locality. The holotype is not known to exist.

Range.—Near Wabash, Ohio, and Mississippi rivers in southern and southeastern Illinois and extreme southwestern Indiana. It may also occur in adjacent parts of the Mississippi River Valley in Kentucky, Missouri, Tennessee, and Arkansas.

Diagnosis.—Externally, medium-sized to large in all features. Cranially, large in most characters, especially large in breadth across M^2 — M^2 , molariform tooththrow length, and breadth across M^3 — M^3 , but with a short unicuspid tooththrow.

Comparisons.—*Sorex c. lesueurii* differs from *S. c. cinereus* primarily in cranial morphology with *S. c. lesueurii* being the larger of the two in all characters (Figure 3 and Table 2) except in length of the unicuspid tooththrows. The relatively short unicuspid tooththrows of *S. c. lesueurii* are especially evident when expressed as a percentage of molariform tooththrow length. Nine of the 10 individuals of *S. c. lesueurii* with the cingulum of the first upper incisor still against its alveolus have unicuspid tooththrows that are 57% or less of molariform tooththrow length, whereas 18 of 20 *S. c. cinereus* of comparable age from Illinois and Indiana have unicuspid tooththrows that are 58% or more of molariform tooththrow length.

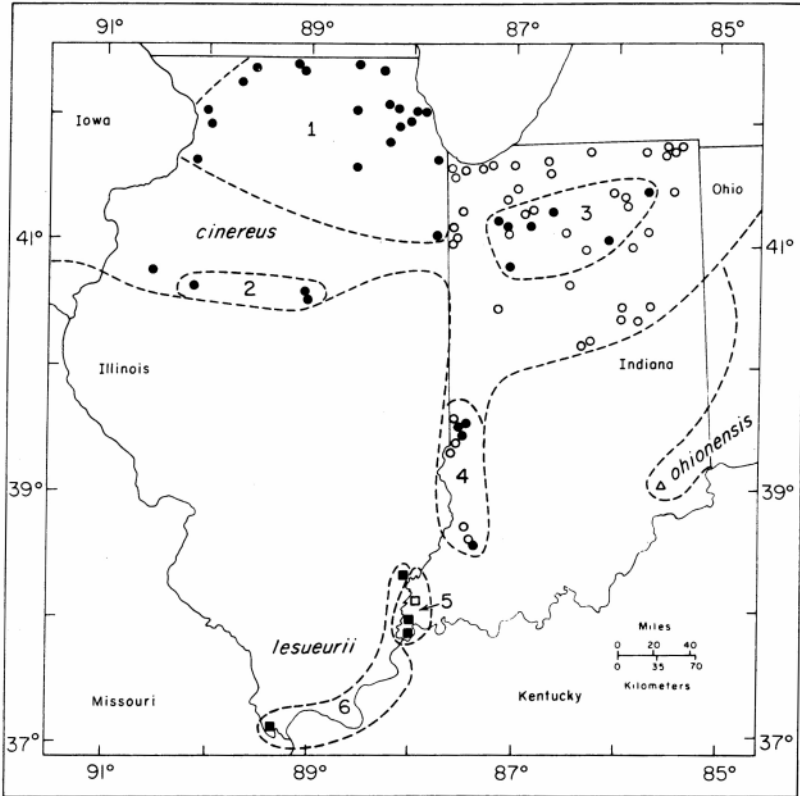


Figure 4. The geographic distribution of *Sorex cinereus* in Illinois and Indiana. Solid symbols represent specimens examined and open symbols represent individuals reported in the literature but not personally examined. *Sorex c. cinereus* is represented by dots, *S. c. lesueurii* by squares, and *S. c. ohionensis* by a triangle. The numbers and dashed lines designate and encircle, respectively, individuals used to compose each of the six samples.

Remarks.—In describing *Amphisorex lesueurii* (= *Sorex c. lesueurii*), Duvernoy (1842:33) recorded the type locality as the Wabash River Valley, Indiana. However, on page 16 Duvernoy noted that his good friend Lesueur collected the type on the banks of the Wabash in the state of Indiana some myriameters from the mouth of the Ohio River (our best translation). Charles Lesueur lived for some time at New Harmony, Posey County, southwestern Indiana, which is in the Wabash River Valley and about 25 miles (approx. four myriameters) north of the junction of the Wabash and Ohio rivers, and it seems extremely likely that the type was collected near here. We therefore fix the type locality of *Amphisorex lesueurii* at New Harmony, Posey County, Indiana.

Table 2. Mean and 1 SD in mm of some of the measurements for each of the six samples of *S. c. cinereus* and *S. c. lesueurii* shown in Figure 4.

Sample	N	Total length	Tail length	Breadth U ³ -U ³	Breadth M ² -M ²	Unicuspid tooththrow 1.	Molariform tooththrow 1.	Maxillary breadth	Lateral breadth U ¹
<i>Sorex cinereus cinereus</i>									
1	16	85.4 7.6	33.4 2.9	1.78 0.05	3.75 0.10	2.24 0.05	3.73 0.07	4.21 0.15	0.63 0.03
2	21	90.9 3.2	34.5 2.5	1.78 0.05	3.75 0.07	2.21 0.10	3.73 0.08	4.16 0.11	0.63 0.03
3	12	87.4 4.6	33.0 2.0	1.75 0.06	3.78 0.09	2.15 0.06	3.74 0.09	4.28 0.08	0.63 0.03
4	7	—	—	1.78 0.06	3.80 0.14	2.13 0.05	3.74 0.10	4.21 0.06	0.63 0.01
<i>Sorex cinereus lesueurii</i>									
5	12	90.0 2.9	34.7 1.4	1.81 0.06	3.94 0.10	2.21 0.07	3.92 0.10	4.39 0.13	0.65 0.02
6	2	93.0 7.1	37.5 3.5	1.84 0.11	4.09 0.00	2.14 0.05	4.01 0.05	4.44 0.03	0.66 0.03

Judging from the illustrations of the type (Duvernoy, 1842, plate 50), we cannot determine with certainty if it is a masked shrew, *S. cinereus*, or a southeastern shrew, *S. longirostris*. The brief description on page 33 does say that the unicuspid decrease in size from anterior to posterior. This is typical of *S. cinereus*; it may occur in this fashion in *S. longirostris*, but it is unusual. Also, *S. cinereus* is common along the banks of the Wabash River where the type was collected, whereas *S. longirostris* seems to be rare in this area but common in places some distance from the river. We therefore feel the type is of the species *S. cinereus*.

When Bole and Moulthrop (1942) described *Sorex cinereus ohionensis* from Ohio, they resurrected the name *Sorex cinereus lesueurii* and applied it to all Indiana *S. cinereus*. The trinomen was later applied to *S. cinereus* from southern Michigan (Burt, 1943), Illinois (Hoffmeister and Mohr, 1957), and eastern Iowa (Schlitter and Bowles, 1968). Analyses presented here indicate that the name *lesueurii* should be restricted to shrews from southern Illinois and extreme southwestern Indiana.

Mumford (1969) referred shrews from extreme southeastern Indiana to *S. cinereus ohionensis*. We did not examine these specimens, but did have available four specimens of *ohionensis* from south-central Ohio for comparisons. *Sorex c. ohionensis* is definitely more similar to *S. c. lesueurii* than to *S. c. cinereus*, but adequate material is not yet available to properly compare *S. c. lesueurii* with *S. c. ohionensis*. If *S. c. lesueurii* and *S. c. ohionensis* prove to be indistinguishable, *S. c. ohionensis* will become a synonym of *S. c. lesueurii*.

Little is known about the habitat requirements of *S. c. lesueurii*, but judging from its close geographical association with the Wabash and Ohio rivers, clearings adjacent to mature riparian habitat may be preferred. The two specimens collected on 25 April 1980 by Woodrow W. Goodpaster near Miller City, Alexander County, Illinois, judging from his field notes, were taken on a rainy night in a clearing in a dense wet forest of gum, oak, and ash. In this clearing, which was grown up in weeds, there was a small stream of water only a few yards wide. The huge trees that were pushed down to make the clearing were in piles on both sides of the stream.

Specimens examined.—ILLINOIS. Alexander Co.: 1¹/₂ mi E, 1¹/₂ mi S Miller City, 2 (UIMNH)'. Edwards Co.: adjacent Mud Creek, 2 mi N Grayville, 1 (UIMNH). INDIANA. Posey Co.: Hovey Lake Fish and Game Area, 8 (UIMNH); Greathouse Island, 5 (IUS); New Harmony, 1 (USNM).

***Sorex cinereus cinereus* Kerr**

1792. *Sorex arcticus cinereus* Kerr, The animal kingdom ... , p. 206.

1925. *Sorex cinereus cinereus*, Jackson, Jour. Mamm., 6:56. Type.—From Fort Severn, Ontario, Canada. The type is not known to exist.

Range.—A trans-boreal distribution from central Alaska eastward to Labrador and eastern United States with finger-like extensions southward along the Rocky and Appalachian mountain chains. In Illinois, throughout the northern third of the state, as far south as Fulton and McLean counties.

Diagnosis.—Externally, medium-sized to large in all features. Cranially, small in most characters, particularly small in breadth across M^2 - M^2 , molariform tooththrow length, and breadth across M^3 - M^3 , but with a long unicuspid tooththrow.

Comparisons.—For comparisons of *S. c. cinereus* with *S. c. lesueurii*, see the account of that subspecies.

Remarks.—*Sorex c. cinereus* has a large geographic distribution in North America but exhibits remarkably little geographic variation within this area. Specimens examined by us from Tennessee and Colorado, widely isolated one from the other, differ little and only slightly from near topotypical specimens from northeastern Manitoba and Ontario. It is therefore surprising to observe the large amount of geographic variation in Illinois and Indiana that distinguishes *S. c. lesueurii* from *S. c. cinereus*.

Cadwell and Brate (1978) reported *S. cinereus* from northern McLean County in north-central Illinois, and suggested that it only recently extended its range this far south. It should be noted, however, that the species may have been in this general area for many years, for Hoffmeister (1954) questioned whether a specimen in alcohol and labeled as "probably from Normal" in McLean County was truly from this area.

Specimens examined.—ILLINOIS. Carroll Co.: Mt. Carroll, 1 (UIMNH); $1/4$ mi W Mt. Carroll, 2 (UIMNH); Fairhaven Twp., 1 (INHS); Carroll Twp., 1 (INHS); Cook Co.: Barrington, 1 (UIMNH); Chicago, Calumet River Preserves, 2 (UIMNH); 4 mi N Des Plaines, on HWY 45, dam No. 2, 2 (UIMNH); 1 mi W Park Ridge, 2 (UIMNH); Evanston, 1 (FMNH); 3 mi N Des Plaines, 3 (INHS). Du Page Co.: 1 mi W Lisle, 1 (UIMNH); 2 mi N, 1 mi W Bensenville, 1 (UIMNH). Fulton Co.: 2.2 mi SW Middle Grove, 22 (UIMNH). Kane Co.: 7.3 mi W, 4.8 mi N Elgin, 1 (UIMNH). Kankakee Co.: 6 mi E St. Anne, 1 (UIMNH). Kendall Co.: Yorkville, 4 (UIMNH). Lake Co.: Fox Lake, 3 (FMNH); Pistakee Bay, 2 (FMNH). McHenry Co.: 1 mi W Hebron, 1 (CWRL). McLean Co.: 2 mi NW Hudson, 2 (ILLSU); $1/4$ mi E route 55 and 51, Normal, 1 (ILLSU). Stephenson Co.: $1\frac{1}{2}$ mi NW Dakota, 1 (UIMNH); 3 mi W Freeport, 1 (UIMNH). Warren Co.: 5 mi NE Roseville, 1 (WIU). Whiteside Co.: 5 mi W Erie, 1 (UIMNH). Winnebago Co.: 2 mi E Roscoe, 1 (UIMNH); 3 mi W S Beloit, 1 (CWRL). INDIANA. Knox Co.: Petersburg at White River, 4 (ISU). Jasper Co.: Tefft, 1 mi S J-P State Fish and Game Area, 5 (UIMNH). Marshall Co.: Culver, 1 (UIMNH). Noble Co.: 2 mi SE Albion, 1 (UIMNH). Pulaski Co.: Jasper-Pulaski Fish and Wildlife Area, 1 (UIMNH); Winamac Fish and Game Area, 1 (UIMNH). Vigo Co.: Honey Creek at US 40, 1 (ISU); West Terre Haute, 1 (USNM); Sugar Creek at US 40, 2 (ISU); Otter Creek at US 41, 1 (ISU). Wabash Co.: Laketon, 1 (ISU). White Co.: 4 mi S Monon, 3 (UIMNH).

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